

# **What FutureCar MPG Levels and Technology Will Be Necessary?**

Phil Patterson, EERE, DOE

Elyse Steiner, NREL

Margaret Singh, ANL

*Future Car Congress*

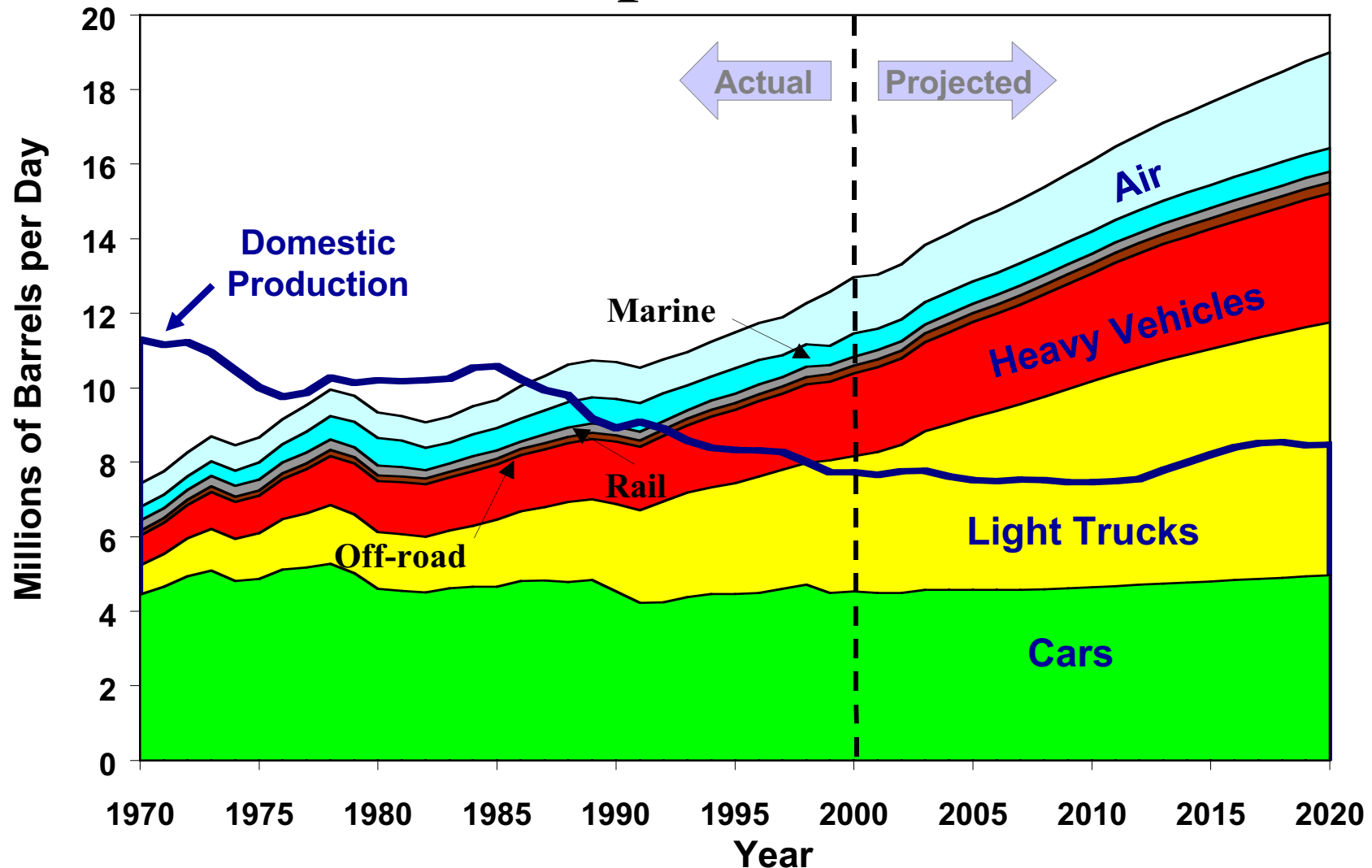
*June 4, 2002*

# **Necessary for What?**

## **To Reduce Oil Use**

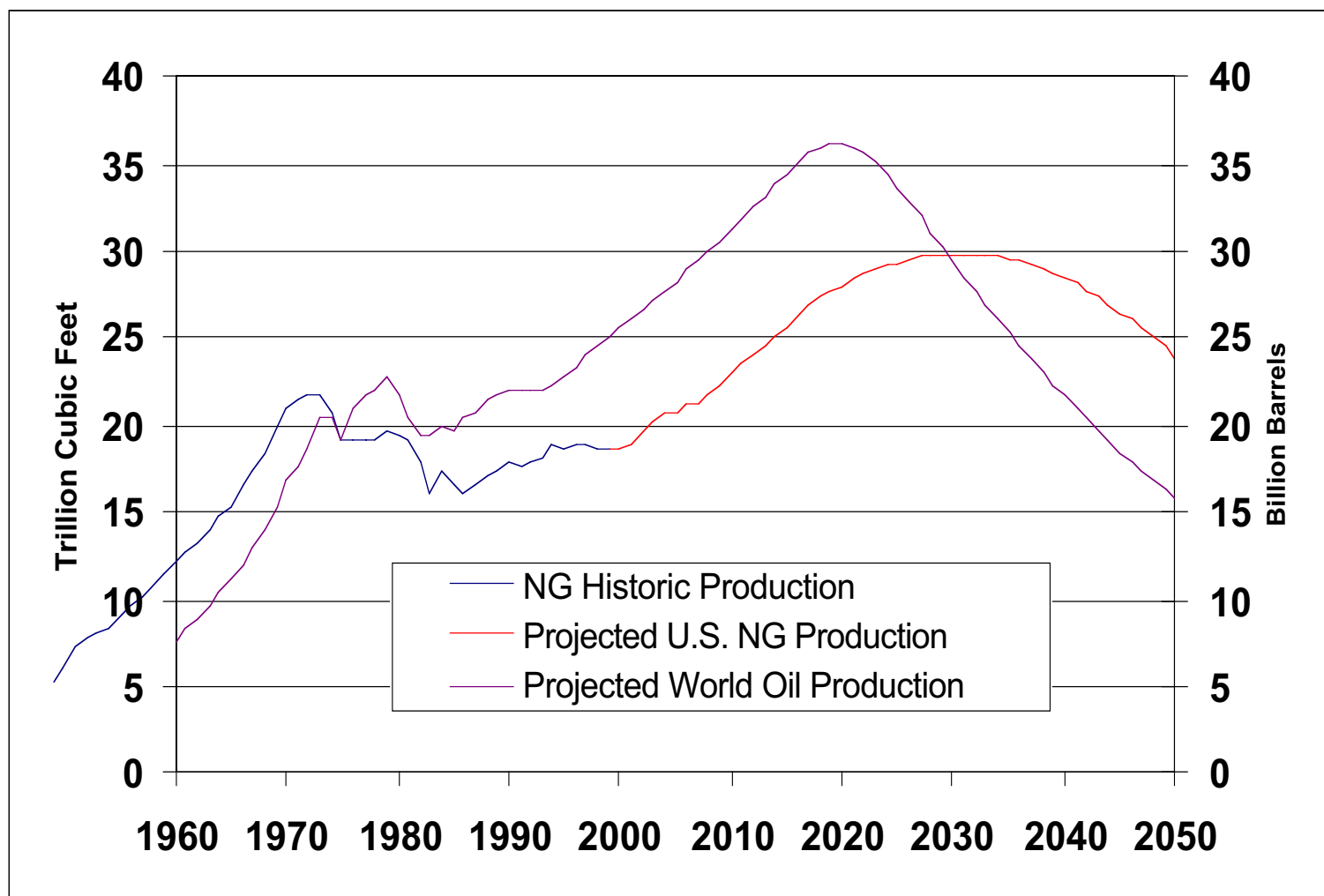
- Dependence: Transportation is 95% and Light Vehicles are 97% dependent on oil
- Oil Security: OPEC accounts for 43% of world oil production and has 79% of world oil reserves
- Import Costs: \$109 billion in 2000 and \$88 billion in 2001 (a fifth to a fourth of our trade deficit)
- Carbon: Transportation accounts for a third of U.S. carbon emissions

# U.S. Transportation Oil Use



Source: Transportation Energy Data Book: Edition 21, DOE/ORNL-6966, September 2001,  
and EIA Annual Energy Outlook 2002, DOE/EIA-0383(2002), December 2001

## Estimate of World Oil Production Peak and U.S. Natural Gas Production Peak



# The Carbon Challenge

To reach the stable carbon levels in 2150 on the left, world emissions need to decline as shown on the right.

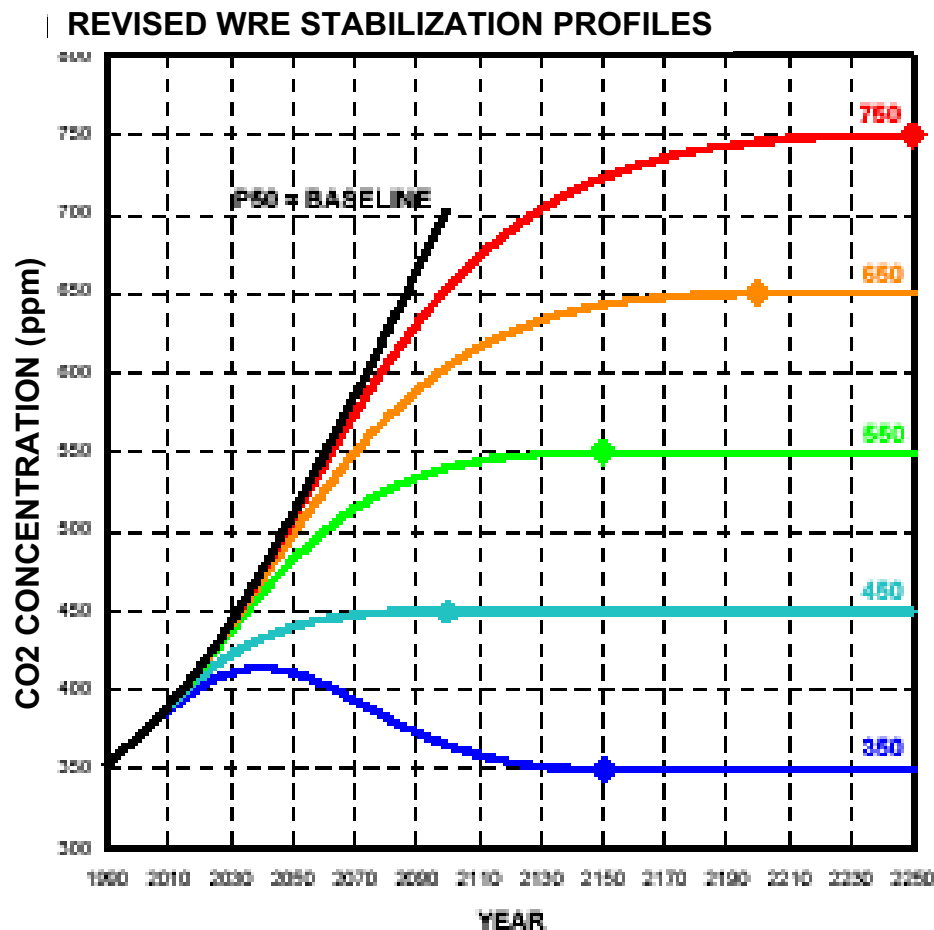
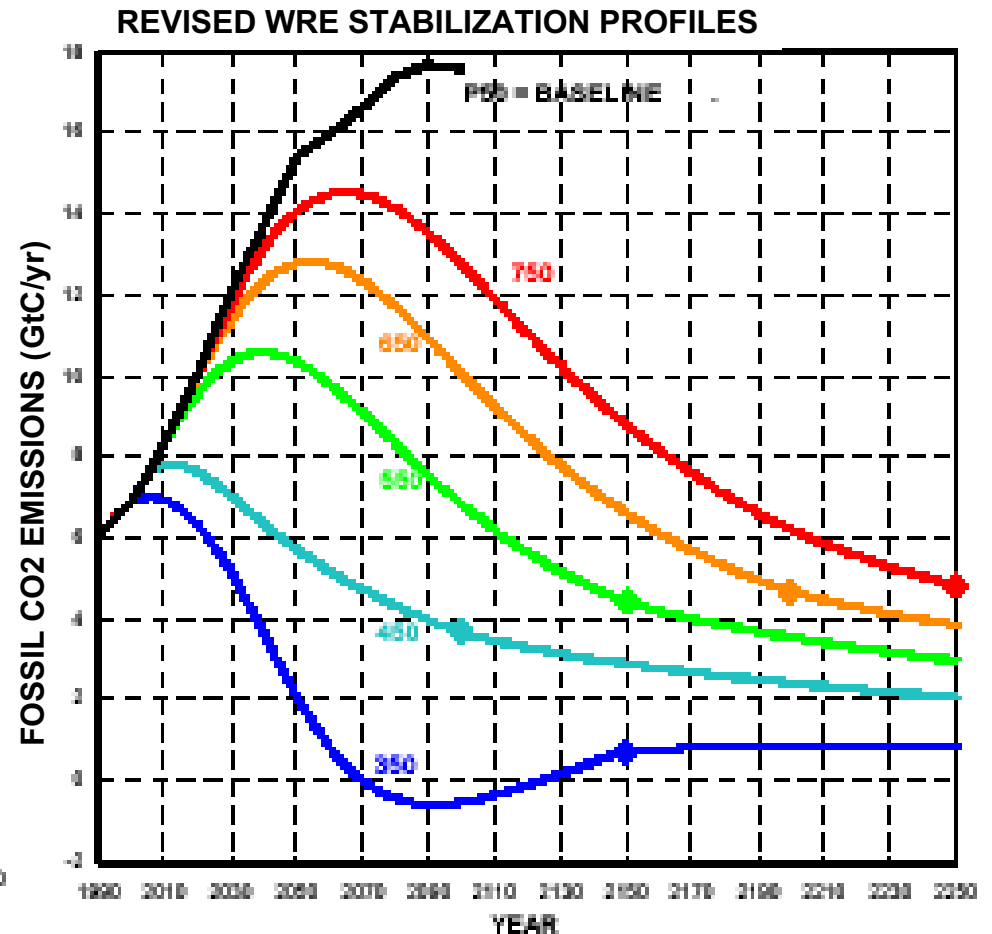


Figure A: Profiles for Various Stabilized CO<sub>2</sub> Concentration Levels

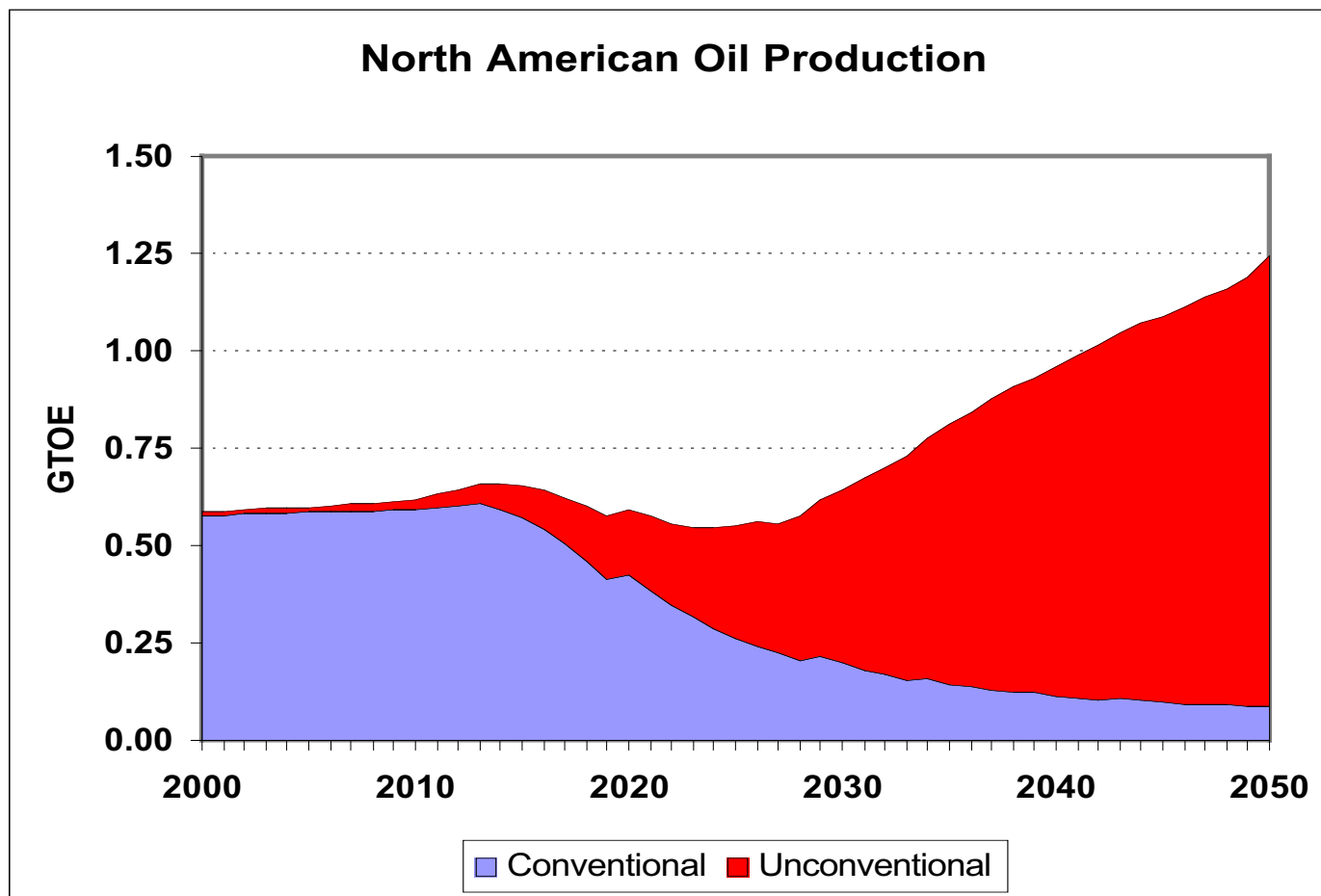


Emission Profiles for the Stabilized CO<sub>2</sub> Concentration Levels of Figure A

## The Substitutes for Conventional Oil Make Different Contributions to National Objectives

|  | Improve<br>Energy<br>Security | Lower<br>the Cost for<br>Imports | Reduce<br>Carbon<br>Emissions |
|--|-------------------------------|----------------------------------|-------------------------------|
| Unconventional Oil<br>– non-North<br>American            |                               |                                  |                               |
| Unconventional Oil<br>– Such as Oil Sands<br>from Canada | +                             |                                  |                               |
| Hydrogen from<br>Natural Gas                             | +                             | ++                               | +                             |
| Ethanol and/or<br>Hydrogen from<br>Renewables            | ++                            | ++                               | ++                            |

# The Vast Majority of North American Unconventional Oil Supply Will Come from Canadian Oil Sands



# **U.S. Light Vehicles Will Need to Use Other Fuels and/or become More Efficient**

- Demand options
  - Improved fuel economy of vehicles
  - Reduced travel demand
- Supply options
  - Unconventional oil (such as, oil sands)
  - Natural gas
  - Biomass ethanol
  - Hydrogen from various sources (natural gas, coal, renewables, nuclear, electricity)

# **The Mix of Supply and Demand Options Chosen Will Be Affected by What We Want to Accomplish**

- Do we want to:
  - Stabilize the absolute amount of fuel use (and at what level)?
  - Reduce the amount of fuel used relative today's consumption?
  - Eliminate the use of petroleum altogether?
  - Avoid the use of fossil fuels?
  - Reduce or zero-out carbon emissions?

# **VISION Model Examines Energy, Oil and Carbon Impacts of Transportation Technologies to 2050**

- Developed to help OTT examine the potential impacts of the research it funds
- Alternative vehicle technologies are included: 6 LDV and 3 HDV types
- 6 alternative transportation fuels (with variation in their resource fuels)
- User specifies market penetration of new technologies (vehicle and fuel), vehicle fuel economy, VMT growth rates
- Annual estimates generated
- *Model was modified in early 2002, so the estimates in this presentation differ from those in the paper*

## Reference Case Assumptions

- New Car fuel economy remains at 28.5 mpg
- Light Truck mpg fixed at 21.2
- Annual vmt growth rate is 2% in 2000 and declines to .8% in 2050
- Light Vehicle oil use grows from 7.6 mbpd in 2000 to 16.2 mbpd in 2050
- Light Vehicle carbon emissions grow from 362 mmtc to 772 mmtc in 2050

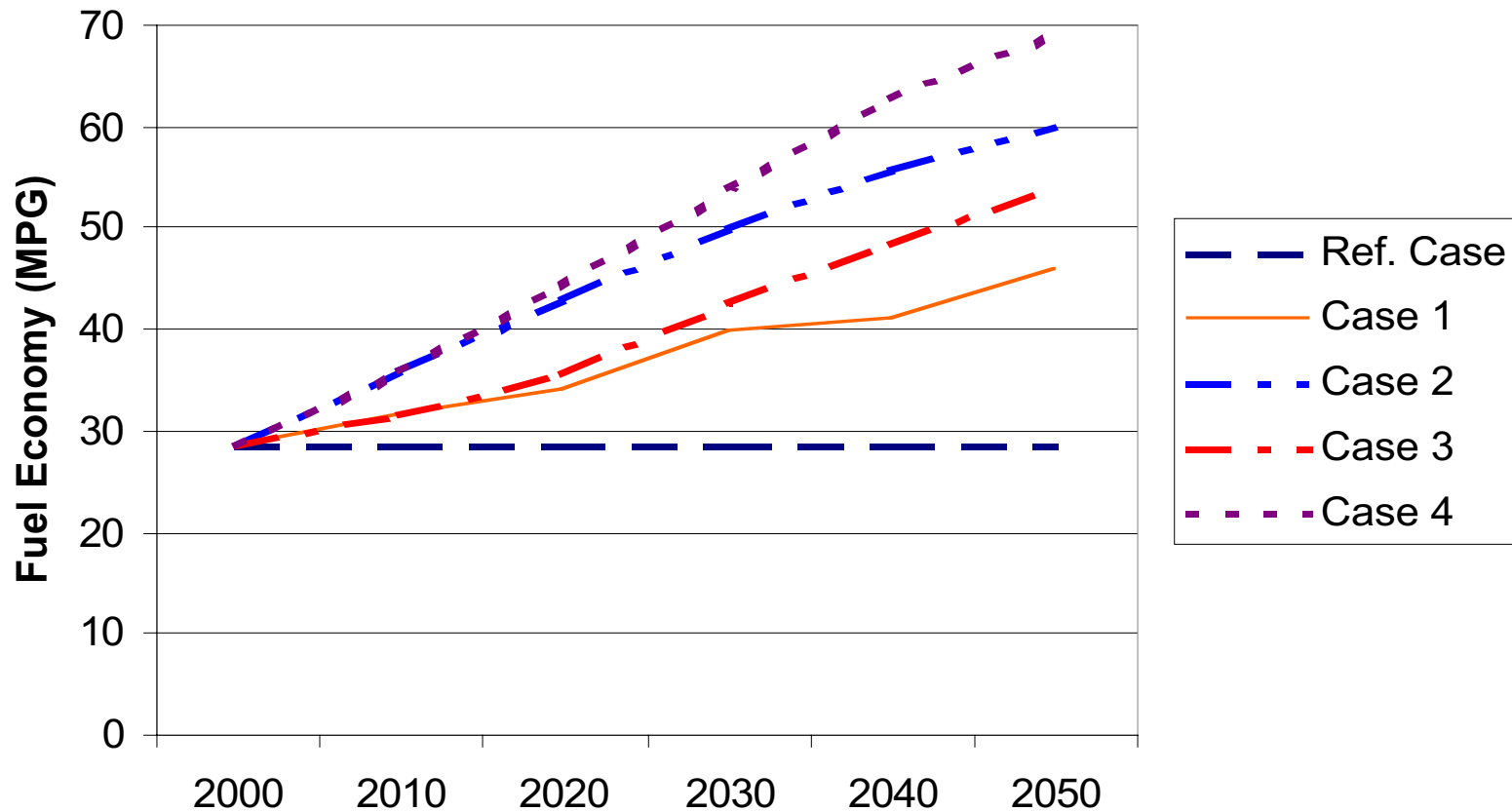
# **VISION Model Used to Analyze Several Goals for Light Vehicles**

- Case 1: Improve MPG so that fuel use will stabilize post-2020 at projected 2020 levels
- Case 2: Improve MPG so that by 2030 fuel use is reduced to the 2000 level and is reduced further in subsequent years
- Case 3 : Case 1 plus 50% ethanol use and 50% low-carbon fuel cell vehicles by 2050
- Case 4 : Case 2 plus 50% ethanol use and 50% low-carbon fuel cell vehicles by 2050

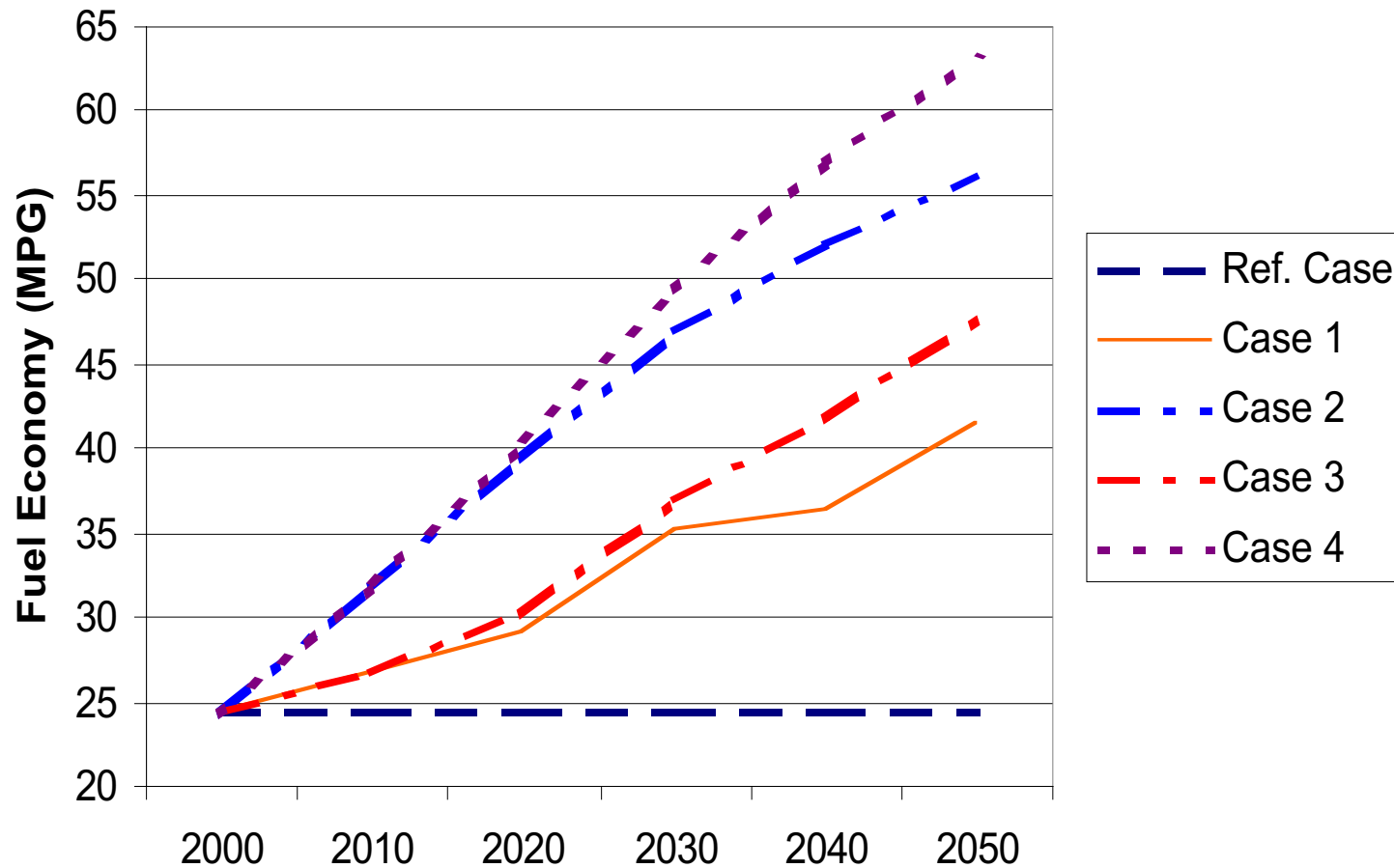
# **Vehicle Fuel Economy Required to Achieve Such Oil Use**

- The fuel economy of new cars (light trucks) would have to reach 46 (38) mpg by 2050 to stabilize LDV oil use at 10 mbpd (2.5 mbpd higher than today) (Case 1)
- The fuel economy of new cars (trucks) would have to reach 60 (53) mpg by 2050 to stabilize LDV oil use at 7.3 mbpd (Case 2)
- The fuel economies are higher in Cases 3 and 4, relative to Cases 1 and 2, because the fuel cell vehicles are more efficient than the vehicles they replace

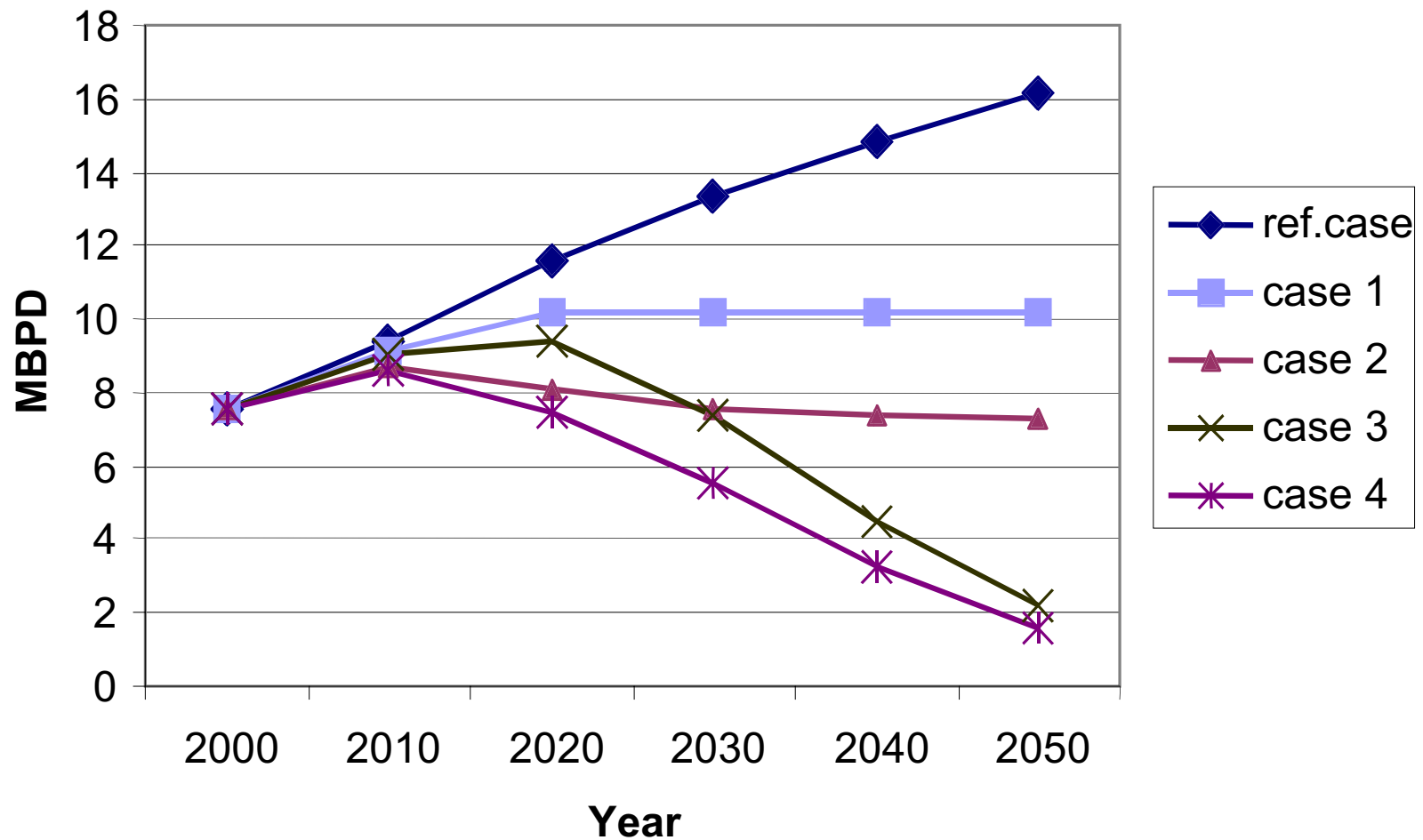
# New Car Fuel Economy Required To Achieve Oil Use Targets



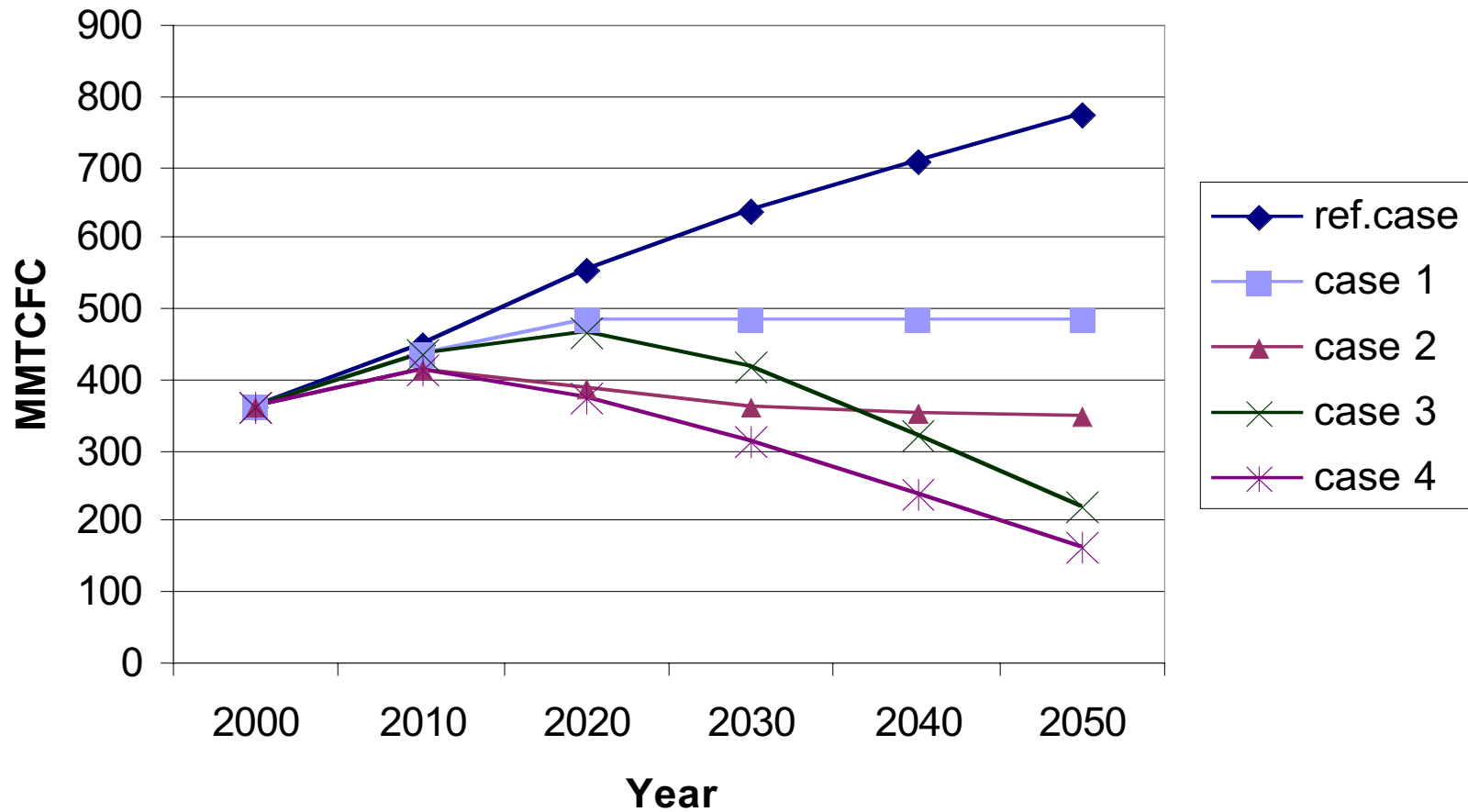
# New Light Vehicle Fuel Economy Required To Achieve Oil Use Targets



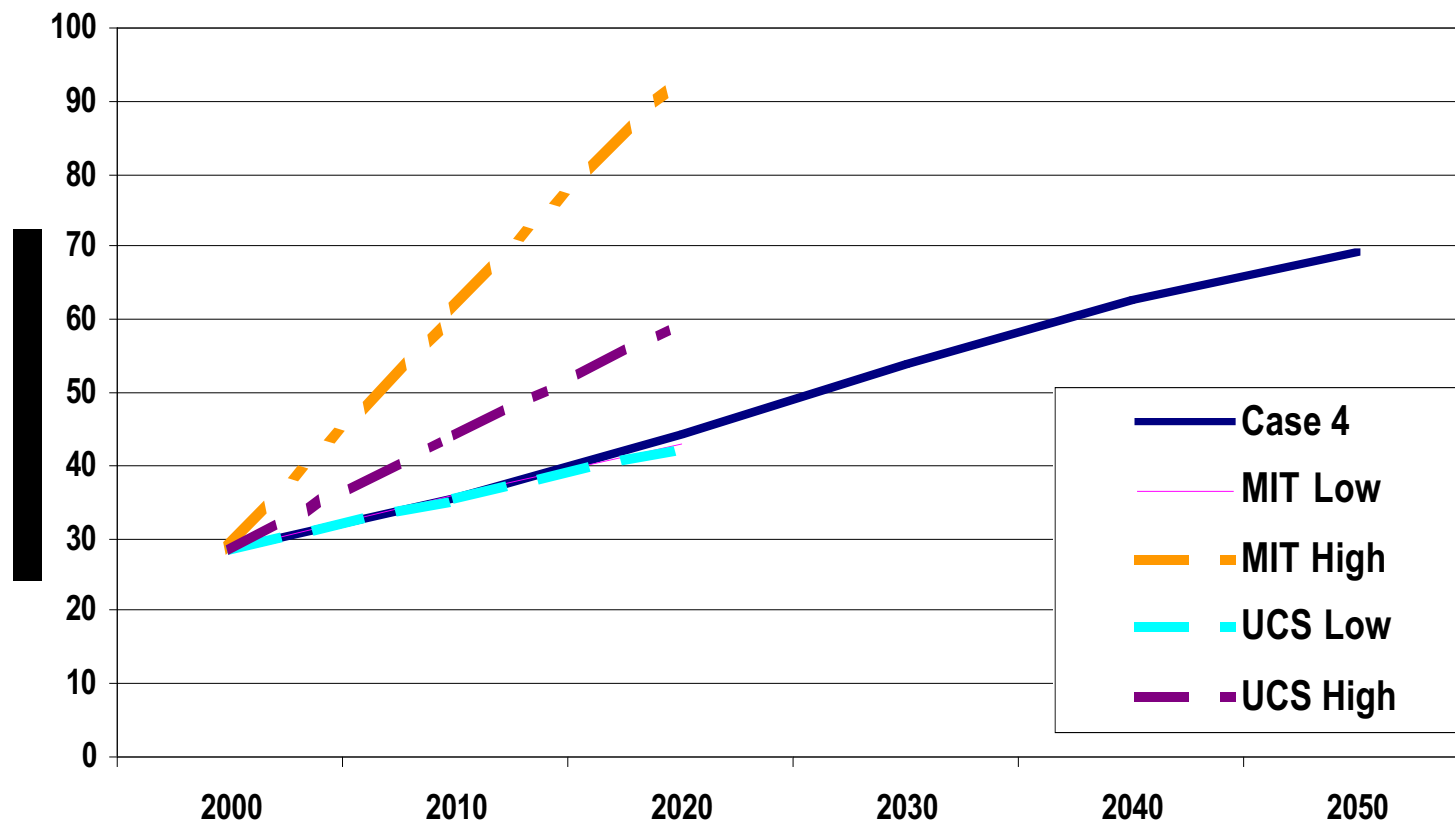
# Light Vehicle Oil Use in These Cases



# Light Vehicle Carbon Emissions



# These Car Fuel Economy Results Are Consistent with What MIT and UCS Studies Say Is Achievable



# Key Conclusions

- It will be necessary to use vehicles with high MPG to achieve oil use and carbon emission targets. This reduces oil use and reduces the amount of alternative fuel needed.
- To reach really low oil use and carbon targets, alternative fuels that are low in carbon will be necessary.
- To make big changes by 2050, it is important to start soon.
- Other goals would require different mpg improvements.

# Other Related Analysis

- WBCSD Sustainable Mobility Project (2030): <http://www.wbcsdmobility.org/>
- Phase 2 of the 2050 Transportation Energy Study
  - Funded by DOE and Natural Resources Canada
  - Reference Case and Three Scenarios
  - Estimating costs of the various pathways to reduce oil use and carbon emissions
  - Two other papers at this conference present analysis conducted as part of this study

# Web Sites

- **Phase 1 Report on 2050 Transportation Energy Use is at:**  
[http://www.ott.doe.gov/future\\_highway.shtml](http://www.ott.doe.gov/future_highway.shtml).
- **VISION Model is available on request.**
- **Other analytic work of interest is at:**  
[http://www.ott.doe.gov/data\\_statistics.shtml](http://www.ott.doe.gov/data_statistics.shtml)
- My e-mail: *philip.patterson@ee.doe.gov*